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Processes Prior to Outbursts of Vulcanian Eruption at Showa Crater of Sakurajima Volcano

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Showa crater of Sakurajima volcano became active in June 2006 after 58 years of quiescence. From multi-parametric geophysical observations, we have identified the processes that typically occur prior to an explosive eruption at the crater. A few hours prior to the onset of an eruption, magma starts to migrate and accumulates at a depth of about 1 km. This accumulation of magma can be clearly observed in strain change records as an inflation process. Several tens of minutes prior to an eruption, the SO_2 gas emission rate gradually decreases, indicating that a sealing process is taking place in the crater bottom as the eruption nears. During the same time period, the volcano's inflation rate starts to accelerate due to the formation of a plug above the conduit that prevents the gas from escaping, with the result that a gas pocket forms beneath the crater. In nighttime events, a volcanic glow is also seen, which weakens and then disappears. A few minutes prior to an eruption, a small tremor starts to occur. Its amplitude grows as the strain changes from inflation to deflation as the stored gas is released through new fractures within the plug that had been confining the gas pocket, leading to a minor depressurization in the conduit. Then, an expansion process starts, that could explain seismically the first motion of an explosion earthquake. This is probably when the effect of depressurization downward from the crater bottom reaches the magma head and a sudden magma expansion with degassing starts. After a short period (about half a second), this expanding magma rises and pushes the gas pocket upward, leading to a swelling of the crater ground along with the radiation of the preceding phase of infrasound waves, and then a breakup occurs. After the plug fails due to deformation, the accumulated gasses and expanding magma are ejected together from the crater as the surface eruption phenomena starts.

Key words: Vulcanian eruption, eruption process, Sakurajima volcano, Showa crater

1. Introduction

Recent interdisciplinary and multi-parametric observations are attempting to elicit in detail the volcanic eruption processes at several active volcanoes including Stromboli, Italy (Calvari *et al.*, 2008) and Soufrière Hills, Montserrat (Voight and Sparks, 2010).

In Japan, Iguchi *et al*. (2008a) discussed the eruption process of the summit crater of Sakurajima volcano, based on integrated geophysical observations, as follows. The process commences with a gradual volcano inflation, which is thought to be induced by a combination of the effects of the ascent of magma and the accumulation of volcanic gas being emitted from the magma. Ishihara (1990) argued that such a gas accumulation leads to the formation of a "gas pocket" beneath the crater bottom. The term "gas pocket" corresponds to a shallow transition zone characterized by complex mingling between vesicular and dense magma a few hundred meters thick, which was mentioned as occurring at the Soufrière Hills volcano (Burgisser *et al.*, 2011). This zone is covered by a dense and strongly degassed plug a few tens of meters thick.

When the accumulated pressure inside the gas pocket exceeds the strength of the plug as gas accumulates, a failure of a tiny part of the plug, such as a fracture within it, may occur (Lyons *et al*., 2012). Then, a minor amount of gas will start escaping into the atmosphere. This leakage of gas induces a pressure decrease in the uppermost part of the conduit as well as within the gas pocket. It has been recognized in the strain change 1.5 min before an eruption (Iguchi *et al*., 2008a). The depressurization in the conduit can then propagate deeper into the volcano as an expansion wave (Turcotte *et al.*, 1990). When this happens, a sudden outgassing of water-saturated magma occurs at a certain depth, which corresponds to the onset of an explosion earthquake in the conduit around 2 km beneath Sakurajima (Ishihara, 1985; Tameguri *et al.*, 2002).

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